

**PATENT COOPERATION TREATY**  
**PCT**

**INTERNATIONAL PRELIMINARY EXAMINATION REPORT**  
(PCT Article 36 and Rule 70)

REC'D 07 JUL 2004

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Applicant's or agent's file reference CH920020023	<b>FOR FURTHER ACTION</b>	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/IB 03/02784	International filing date (day/month/year) 17.06.2003	Priority date (day/month/year) 28.06.2002
International Patent Classification (IPC) or both national classification and IPC H04L1/00		
Applicant INTERNATIONAL BUSINESS MACHINES CORPORATION et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 5 sheets.

3. This report contains indications relating to the following items:

- I  Basis of the opinion
- II  Priority
- III  Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV  Lack of unity of invention
- V  Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI  Certain documents cited
- VII  Certain defects in the international application
- VIII  Certain observations on the international application

Date of submission of the demand 21.01.2004	Date of completion of this report 06.07.2004
Name and mailing address of the international preliminary examining authority:   European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer  Agudo Cortada, E Telephone No. +49 89 2399-7111



**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. PCT/IB 03/02784

**I. Basis of the report**

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

**Description, Pages**

1, 2, 4-13 as originally filed  
3, 3a received on 27.05.2004 with letter of 24.05.2004

**Claims, Numbers**

1-12 received on 27.05.2004 with letter of 24.05.2004

**Drawings, Sheets**

1/2-2/2 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- the language of publication of the international application (under Rule 48.3(b)).
- the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- contained in the international application in written form.
- filed together with the international application in computer readable form.
- furnished subsequently to this Authority in written form.
- furnished subsequently to this Authority in computer readable form.
- The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- the description, pages:
- the claims, Nos.:
- the drawings, sheets:

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5.  This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

*(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

**1. Statement**

Novelty (N)	Yes: Claims	1-12
	No: Claims	
Inventive step (IS)	Yes: Claims	1-12
	No: Claims	
Industrial applicability (IA)	Yes: Claims	1-12
	No: Claims	

**2. Citations and explanations**

**see separate sheet**

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EXAMINATION REPORT - SEPARATE SHEET**

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**Ad. Section V**

**CLAIM 1**

The present application relates to a method and apparatus for adapting a transmission parameter in a transmitting node of a data communication system to the current link quality of a data communication channel.

Such a method and apparatus is known from documents D1 (YU-DONG YAO: "AN EFFECTIVE GO-BACK-N ARQ SCHEME FOR VARIABLE-ERROR-RATE CHANNELS" IEEE TRANSACTIONS ON COMMUNICATIONS, IEEE INC. NEW YORK, US, vol. 43, no. 1, 1995, pages 20-23, XP000487372 ISSN: 0090-6778) and D2 (WO 02/25856 A), which describe and adaptation of the transmission parameters based on the results of prior transmissions. This is achieved by having a threshold value for successful transmissions. If this threshold is reached, a new, more appropriate parameter set is used to increase the transmission rate for the next transmission.

The difference between the subject-matter of independent claim 1 and the disclosure of D1 and D2 is that the threshold is made dependent on the state of the channel.

The objective technical problem can be regarded as taking into account in the adaptation scheme the speed at which the quality of the channel is improving. To this end, the threshold is changed in the invention in dependence of the success or failure of a transmission following a change in the transmission parameters.

There is nothing in D1 or D2, alone or in combination, to suggest the skilled person such an adaptation of the threshold, and therefore, independent claim 1 meet the requirements of Article 33 PCT.

**CLAIMS 9, 10 AND 11**

Independent claims 11 claims protection for the same inventive concept in terms of apparatus features. Independent claims 9 and 10 claims protection for a computer program and computer program product for carrying out the steps of the method claims 1-8. Therefore, these claims also satisfy the requirements of Article 33 PCT

**CLAIMS 2-8 and 12**

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Dependent claims 2-8 and 12 contain further details of the method of independent claims 1 and apparatus of independent claim 11 respectively. As they are dependent on these claims, they also satisfy the requirements of Article 33 PCT.

**CLARITY REQUIREMENTS**

The vague and general statement in the description on page 13 implies that the subject-matter for which protection is sought may be different to that defined by the claims, thereby resulting in lack of clarity (Article 6 PCT) when used to interpret them. According to this statement, even an idea written in a paper about how to perform the method steps of the method claims would fall under the scope of protection of claims 9 and 10.

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why the link adaptation method described by G. Holland et. al. in "A Rate-Adaptive MAC Protocol for Multi-Hop Wireless Networks", ACM/IEEE International Conference on Mobile Computing and Networking (MOBICOM'01) Rome, Italy, July 2001, cannot be applied to current IEEE 802.11 WLANs, since it is based on the principle that the receiver determines  
5 the link quality and requests the transmitter to switch to a more appropriate rate.

The article by Yo-Dong Yao "An Effective Go-Back-N ARQ Scheme for Variable-Error-Rate Channels", in IEEE Transactions and Communications, vol. 43, no. 1, 1995, pages 20-23, ISSN: 0090-6678, relates to a go-back-N ARQ (automatic-repeat-request) scheme which estimates the channel state based on acknowledge messages received and adaptively switches  
10 its ARQ operation mode.

The international publication WO 02/25856 relates to a system that adapts wireless link parameters for a wireless communication link. A measure is determined of errors occurring in communication over a wireless link. In a case that the measure of errors corresponds to more errors than a first predetermined threshold, communication changes from a first set of wireless  
15 link parameters to a second set of wireless link parameters. The second set of wireless link parameters corresponds to higher error tolerance than the first set of wireless link parameters. In a case that the measure of errors corresponds to fewer errors than a second predetermined threshold, communication changes from the first set of wireless link parameters to a third set of wireless link parameters. The third set of wireless link parameters corresponds to lower  
20 error tolerance than the first set of wireless link parameters. The measure of errors is determined by monitoring a number of NACK messages and a number of ACK messages that occur. It is determined that the measure of errors corresponds to more errors than the first predetermined threshold when more than a predetermined number of NACK messages occur in succession. It is determined that the measure of errors corresponds to fewer errors than the  
25 second predetermined threshold when more than a predetermined number of ACK messages occur in succession.

From the above it follows that there is still a need in the art for an improved and efficient link adaptation method. Moreover, only information available at the transmitter side should be sufficient to guess whether the actual link quality is improving or worsening.

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## SUMMARY AND ADVANTAGES OF THE INVENTION

In accordance with the present invention, a method for adapting a transmission parameter in a transmitting node of a data communication system to the current link quality of a data communication channel is provided. The adapted transmission parameter is selected by the  
5 transmitting node from a set of transmission parameters in dependence on a number of successful transmissions s. The number of successful transmissions s is compared in the transmitting node against one of a first value s<sub>1</sub> corresponding to a first state of the transmitting node and a second value s<sub>2</sub> corresponding to a second state of the transmitting node. The method comprises in the transmitting node the steps of (a) counting the number of  
10 successful transmissions s; (b) selecting the adapted transmission parameter (b1) in response to the number of successful transmissions s equaling or exceeding the first value s<sub>1</sub> when the transmitting node is in the first state, and (b2) in response to the number of successful transmissions s equaling or exceeding the second value s<sub>2</sub> when the transmitting node is in the second state; and in dependence of the result of a following transmission, operating the  
15 transmitting node in one of the first state and the second state. The first value s<sub>1</sub> is hereafter also referred to as first threshold value s<sub>1</sub> and the second value s<sub>2</sub> is hereafter also referred to as second threshold value s<sub>2</sub>.

Preferably, the second threshold value s<sub>2</sub> is larger than the first threshold value s<sub>1</sub>, because then the first state can correspond to a link with fast changing quality and the second state can  
20 correspond to a link with slow changing quality.

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**CLAIMS**

1. A method for adapting a transmission parameter in a transmitting node (1) of a data communication system (8) to the current link quality of a data communication channel (7), the adapted transmission parameter being selected by the transmitting node (1) from a

5 set of transmission parameters in dependence on a number of successful transmissions (s), the number of successful transmissions (s) being compared in the transmitting node (1) against one of a first value (s1) corresponding to a first state (H) of the transmitting node (1) and a second value (s2) corresponding to a second state (L) of the transmitting node (1), the method comprising in the transmitting node (1) the steps of:

10 counting the number of successful transmissions (s);

selecting the adapted transmission parameter

in response to the number of successful transmissions (s) equaling or exceeding the first value (s1) when the transmitting node (1) is in the first state (H), and

15 in response to the number of successful transmissions (s) equaling or exceeding the second value (s2) when the transmitting node (1) is in the second state (L); and

in dependence of the success or failure of a subsequent transmission, operating the transmitting node (1) in one of the first state (H) and the second state (L).

2. Method according to claim 1, wherein the step of operating the transmitting node (1) in the second state (L) further comprises in the event of a faulty transmission transitioning to

20 the first state (H).

3. Method according to any preceding claim further comprising setting the first value (s1) to 3 and the second value (s2) to 10.

4. Method according to any preceding claim further comprising counting a number of faulty transmissions (f) and selecting the adapted transmission parameter in dependence of a

25 threshold of the number of faulty transmissions ( $f_T$ ).

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5. Method according to claim 4 further comprising setting the threshold of the number of faulty transmissions ( $f_T$ ) to 1.
  6. Method according to any preceding claim further comprising selecting the transmission parameter used by a responding receiver (2).
- 5      7. Method according to any preceding claim, wherein the step of selecting the adapted transmission parameter further comprises selecting a different data rate.
8. Method according to any preceding claim, wherein the step of selecting the adapted transmission parameter further comprises selecting a packet length different to the length used before.
- 10     9. A computer program comprising program code means for performing the steps of the method of any of the claims 1 to 8 when said program is run on a computer.
10. A computer program product stored on a computer usable medium, comprising computer readable program means for causing a computer to perform the steps of the method of any of the preceding claims 1 to 8.
- 15     11. An apparatus (1) for adapting a transmission parameter to the current link quality of a data communication channel (7), the adapted transmission parameter being selected from a set of transmission parameters in dependence on a number of successful transmissions (s), the number of successful transmissions (s) being compared against one of a first value (s1) corresponding to a first state (H) of the apparatus and a second value (s2) corresponding to a second state (L) of the apparatus, the apparatus comprising:  
a success counter (10) for counting the number of successful transmissions (s);  
a selecting unit (12) for selecting the adapted transmission parameter

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in response to the number of successful transmissions (s) equaling or exceeding the first value (s1) when the apparatus is in the first state (H), and

in response to the number of successful transmissions (s) equaling or exceeding the second value (s2) when the apparatus is in the second state (L); and

- 5 a decision unit (14) which in dependence of the success or failure of a subsequent transmission informs the selecting unit (12) to operate in one of the first state (H) and the second state (L).

12. Apparatus according to claim 11 further comprising a failure counter for counting a number of faulty transmissions (f).

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